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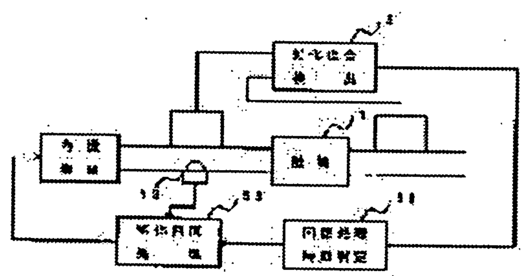
(54) DEVICE FOR PURIFYING EXHAUST GAS OF INTERNAL COMBUSTION ENGINE

(57)Abstract:
PURPOSE: To perform recovery treatment to recover catalytic performance when a catalyst is temporarily deteriorated.
CONSTITUTION: There are provided a catalyst 1 for purifying exhaust gas in which palladium is mainly deposited as catalytic metal installed in an engine exhaust gas system, a deterioration degree detecting means 51 for detecting the degree of deterioration of the catalyst 1, an exhaust gas temp. detecting means 13 for detecting the temp. of exhaust gas flowing in the catalyst 1, a means 52 for judging if the time is ripe for the deterioration recovery treatment of the catalyst 1 according to the catalyst deterioration degree detected, and a means 53 for controlling the air/fuel ratio of exhaust gas to the deterioration recovery air/fuel ratio on the lean side rather than the theoretical air/fuel ratio to perform the deterioration recovery treatment of the catalyst 1 when the judged result is that the time is ripe for the deterioration recovery treatment and the detected exhaust gas temp. is not less than the prescribed one.



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CLAIMS

[Claim(s)]
[Claim 1] The catalyst for exhaust air clarification installed in the engine exhaust air system which made palladium mainly support as a catalyst metal, A degradation degree detection means to detect the degradation degree of this catalyst, and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst, A degradation recovery stage judging means to judge the stage to perform degradation recovery of a catalyst according to the detected catalyst de-activation degree, The exhaust emission control device of the internal combustion engine characterized by having a degradation recovery means to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is this judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value.
[Claim 2] The catalyst for exhaust air clarification installed in the engine exhaust air system which made palladium mainly support as a catalyst metal, A degradation degree detection means to detect the degradation degree of this catalyst, and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst, A degradation recovery stage judging means to judge the stage to perform degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery time setting means to set up the time amount which performs degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery means to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is said judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value, The exhaust emission control device of the internal combustion engine characterized by having a degradation recovery termination means to terminate degradation recovery when the degradation recovery time amount to which the addition time amount after shifting to this degradation recovery was set is reached.
[Claim 3] An exposure possible time amount presumption means to presume time amount when said degradation recovery stage judging means exposes a catalyst to the exhaust air beyond predetermined temperature based on the detection value of the catalyst de-activation degree immediately after engine start up, until a degradation degree advances across tolerance, The exhaust emission control device of an internal combustion engine according to claim 1 or 2 which consists of comparison test means to compare an exposure time addition means to integrate the time amount this detected exhaust-gas temperature of whose is beyond a predetermined value with the exposure possible time amount presumed to be the integrated exposure time, and to judge a degradation recovery stage.
[Claim 4] A storage means by which said degradation recovery stage judging means memorizes the degradation degree which the degradation degree detection means detected immediately after engine start up as an initial degradation degree, A degradation percentage-of-completion calculation means to compute the difference of the degradation degree and initial degradation degree which were detected for every predetermined time, The exhaust emission control device

of an internal combustion engine according to claim 1 or 2 which consists of comparison test means to compare this degradation percentage of completion with the reference value set up according to an initial degradation degree, and to judge a degradation recovery stage.
[Claim 5] Said degradation recovery means is the exhaust emission control device of the internal combustion engine of any one publication of claim 1-4 which the feedback control multiplier when carrying out feedback control of an engine's air-fuel ratio to theoretical air fuel ratio is amended [internal combustion engine], and shifts an air-fuel ratio to the Lean side.
[Claim 6] Said degradation recovery means is the exhaust emission control device of the internal combustion engine of any one publication of claim 1-4 which secondary air is introduced [internal combustion engine] into the upstream of the catalyst installed in the flueway, and shifts the air-fuel ratio of catalyst inflow exhaust air to the Lean side.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to an internal combustion engine's exhaust emission control device.
[0002]
[Description of the Prior Art] While carrying out feedback control of the air-fuel ratio so that it may become theoretical air fuel ratio in order to defecate the exhaust gas discharged by the internal combustion engine, the system which installed in the flueway the three way component catalyst which performs oxidation of HC and CO and reduction of NO simultaneously is put in practical use widely.
[0003] What used as the principal component the palladium excellent in low-temperature activity which functions good [from] among short time after engine start up as a catalyst metal used for this three way component catalyst is developed (refer to JP,58-189037,A).
[0004] Oxide of palladium (Pd) is stable in ordinary temperature, and it demonstrates a catalysis as oxidization palladium (PdO).
[0005]
[Problem(s) to be Solved by the Invention] By the way, if a palladium system catalyst is an air-fuel ratio by the side of rich and is exposed to a hot exhaust air ambient atmosphere rather than theoretical air fuel ratio, it will be returned to metal palladium and it will cause degradation temporarily [so-called] the catalyst engine performance falls temporarily. Degradation appears temporarily [this] notably [the catalyst to which permanent degradation which breaks out by reduction of the specific surface area by heat deformation of a wash coat, reduction of degree of dispersion of noble metals, etc. progressed].
[0006] If momentary degradation of a catalyst breaks out, the cleaning effect of exhaust air will fall and exhaust air emission will increase in the meantime.
[0007] Then, when degradation is caused in this way temporarily, this invention performs degradation recovery of a catalyst and aims at recovering the catalyst engine performance.
[0008]
[Means for Solving the Problem] The catalyst for exhaust air clarification with which the 1st invention is installed in the engine exhaust air system which made palladium mainly support as a catalyst metal as shown in drawing 14 (1), A degradation degree detection means 51 to detect the degradation degree of this catalyst (1), and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst (1) (13), A degradation recovery stage judging means 52 to judge the stage to perform degradation recovery of a catalyst (1) according to the detected catalyst de-activation degree, When the exhaust-gas temperature with which there is this judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value, it has a degradation recovery means 53 to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst (1).
[0009] The catalyst for exhaust air clarification with which the 2nd invention is installed in the engine exhaust air system which made palladium mainly support as a catalyst metal as shown in

drawing 15 (1), A degradation degree detection means 51 to detect the degradation degree of this catalyst (1), and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst (1) (13), A degradation recovery stage judging means 52 to judge the stage to perform degradation recovery of a catalyst (1) according to the detected catalyst de-activation degree, A degradation recovery time setting means 54 to set up the time amount which performs degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery means 53 to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is said judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value, When the degradation recovery time amount to which the addition time amount after shifting to this degradation recovery was set is reached, it has a degradation recovery termination means 55 to terminate degradation recovery.

[0010] The 3rd invention is set to the 1st or 2nd invention. Said degradation recovery stage judging means An exposure possible time amount presumption means to presume time amount when a catalyst is exposed to the exhaust air beyond predetermined temperature, until a degradation degree advances across tolerance based on the detection value of the catalyst de-activation degree immediately after engine start up, This detected exhaust-gas temperature consists of comparison test means to compare an exposure time addition means to integrate the time amount which is beyond a predetermined value with the exposure possible time amount presumed to be the integrated exposure time, and to judge a degradation recovery stage.

[0011] A storage means by which the 4th invention memorizes the degradation degree which the degradation degree detection means detected [said degradation recovery stage judging means] just behind engine start up as an initial degradation degree in the 1st or 2nd invention, It consists of comparison test means to compare a degradation percentage-of-completion calculation means to compute the difference of the degradation degree and initial degradation degree which were detected for every predetermined time with this degradation percentage of completion and the reference value set up according to an initial degradation degree, and to judge a degradation recovery stage.

[0012] In the 1st - the 4th invention, said degradation recovery means amends the feedback control multiplier when carrying out feedback control of an engine's air-fuel ratio to theoretical air fuel ratio, and the 5th invention shifts an air-fuel ratio to the Lean side.

[0013] In the 1st - the 4th invention, said degradation recovery means introduces secondary air into the upstream of the catalyst installed in the flueway, and the 6th invention shifts the air-fuel ratio of catalyst inflow exhaust air to the Lean side.

[0014]

[Function] In the 1st invention, when temporary degradation of a catalyst is judged and an exhaust-gas temperature is beyond a predetermined value, an air-fuel ratio is controlled rather than theoretical air fuel ratio at the Lean side, and catalyst recovery is performed. By being exposed to hot lean atmosphere, momentary degradation of a catalyst is removed and the catalyst engine performance recovers a palladium system catalyst.

[0015] Therefore, when degradation of a catalyst is judged, by carrying out recovery of a catalyst in this way, it becomes possible to bring about the engine performance stabilized in the long run for the catalyst, and a good exhaust air clarification function can be maintained.

[0016] In the 2nd invention, when it decides on time amount required for degradation recovery according to the degradation degree of a catalyst and only this setup time performs recovery, effect which exerts an air-fuel ratio on the operability accompanying degradation recovery and the exhaust air engine performance which are Lean-ized is lessened as much as possible, and recovery of a catalyst can be carried out efficiently.

[0017] In the 3rd invention, the degradation recovery stage is judged in relation to the permanent degradation degree of the catalyst detected immediately after engine start up. Degradation is recovered also by leaving it in ordinary temperature temporarily which is recovered by elevated-temperature lean atmosphere, and a catalyst will be recovered if an engine is stopped. Therefore, the initial degradation degree detected immediately after an engine's start up expresses

degradation which cannot recover a catalyst, i.e., permanent degradation. Depending on extent of permanent degradation, as for the speed of progress of degradation, progress speeds up temporarily, so that a permanent degradation degree becomes large. Therefore, a degradation recovery stage can be judged to accuracy by presuming time amount until degradation of a catalyst arrives at tolerance according to extent of this permanent degradation.

[0018] In the 4th invention, the degradation recovery stage is judged according to the comparison with an initial degradation degree and the degradation degree for every predetermined time. A stage until degradation of the whole which doubled degradation and permanent degradation temporarily arrives at tolerance can be judged to accuracy by expressing the magnitude of degradation temporarily which advanced during that operation, therefore measuring this degradation percentage of completion with the reference value according to an initial degradation degree, the difference, i.e., the degradation percentage of completion, of an initial degradation degree and the degradation degree for every predetermined time.

[0019] In the 5th invention, since the control factor (for example, a proportion value, an integral value) of feed back control of air-fuel ratio is amended and an air-fuel ratio is Lean-ized, the addition of the new hard configuration for it becomes unnecessary.

[0020] In the 6th invention, since an air-fuel ratio is Lean-ized by installation of secondary air, it is operated with the air-fuel ratio of the usual control range, and an engine can secure operability good also in degradation recovery for theoretical air fuel ratio etc.

[0021]

[Example] Drawing 1 shows the example of this invention and a fuel injection valve 5 injects a fuel according to a mounting eclipse and the signal from a controller 4 in the inhalation-of-air path 8 of an engine 7. The three way component catalyst 1 which performs simultaneously HC under exhaust air, oxidation of CO, and reduction of NO is installed in a flueway 9. This three way component catalyst 1 is constituted from a palladium system catalyst which made palladium (Pd) mainly support Seria etc. as a catalyst metal in addition to this by the alumina.

[0022] The 1st and 2nd oxygen sensor 2 and 3 is installed in the upstream and the lower stream of a river of a three way component catalyst 1, respectively, and the controller 4 is carrying out feedback control of said fuel injection volume so that an air-fuel ratio may turn into theoretical air fuel ratio based on the output of the 1st oxygen sensor 2. Moreover, the degradation degree of a catalyst is detected and degradation recovery of a catalyst is performed at a predetermined operation stage corresponding to this degradation so that the output of the 1st oxygen sensor 2 and the 2nd oxygen sensor 3 may measure and mention later the count reversed to Rich Lean, respectively. In addition, for this reason, the signal from the coolant temperature sensor 12 which detects engine-cooling-water **, and the temperature sensor 13 which detects the exhaust-gas temperature of the entrance side of a three way component catalyst 1 inputs into a controller 4. Moreover, although not illustrated, the signal representing operational status, such as an engine inhalation air content and a rotational frequency, is also inputted.

[0023] In addition, the exhaust air reflux path 14 which flows back the exhaust air from [a part of] a flueway 9 is connected to the inhalation-of-air path 8, the exhaust air reflux control valve 15 controls the amount of reflux of exhaust air according to a service condition through a controller 4, and NO under exhaust air is decreased.

[0024] As shown also in drawing 2 , the palladium system catalyst has the property that the catalyst engine performance deteriorates temporarily, by exposing in theoretical air fuel ratio or an elevated-temperature exhaust air ambient atmosphere more rich than it. Moreover, it generates like the catalyst also with common permanent degradation accompanying physical degradation of a catalyst apart from this. Temperature is 500 degrees C and what was illustrated expresses the condition (momentary degradation) of change of a catalyst invert ratio when an air-fuel ratio exposes a rear-spring-supporter palladium system catalyst to long duration at elevated-temperature exhaust air of theoretical air fuel ratio (lambda= 1). In this case, although the catalyst invert ratio falls with the passage of time, the catalyst A with little permanent degradation has little change, on the other hand, in Catalysts B and C and the thing to which permanent degradation progressed, decline in an invert ratio appears notably. About momentary degradation of a catalyst, it can recover in the elevated-temperature exhaust air ambient

atmosphere of the Lean air-fuel ratio, and the catalyst engine performance is recovered to the condition of the beginning of permanent degradation, respectively. Therefore, if the condition of momentary degradation of a catalyst is judged, it will be the service condition from which an exhaust-gas temperature serves as an elevated temperature, and the catalyst which deteriorated will be recovered by controlling an air-fuel ratio to Lean temporarily.

[0025] In order to perform degradation recovery of such a catalyst, a controller 4 performs control shown in drawing 3 - drawing 9 .

[0026] First, drawing 3 is a control routine for judging degradation of a catalyst, and is performed only once after an engine's start up.

[0027] If the engine cooling water temperature Tw is read at step S1, it will judge whether the cooling water temperature Tw judges whether it is more than predetermined value T1 of for example, an after [warming-up termination], and, subsequently to the feedback control field of an air-fuel ratio, there is at step S3 at step S2. [any]

[0028] In addition, when all differ, it returns first.

[0029] In step S4 and 5, the reversal frequencies F1 and F2 of Rich Lean of the output of the 1st oxygen sensor 2 of the catalyst upstream and the 2nd down-stream oxygen sensor 3 are read, respectively. The ratio of a reversal frequency and F2/F1 approach 1, so that the degradation degree of a catalyst progresses, as shown in drawing 4 . Since storage of the oxygen under exhaust air is carried out while the catalyst is functioning normally, the oxygen contained during upstream exhaust air is undetectable as it is on the lower stream of a river of a catalyst. However, if a catalyst deteriorates, in order [to which the oxygen under upstream exhaust air flows down-stream as it is] to come out, the reversal frequency of a down-stream oxygen sensor output will approach the reversal frequency of an upstream oxygen sensor output.

[0030] In step S6, this reversal frequency ratio Fr is computed as F2/F1, and this frequency ratio Fr is compared with the predetermined value Fra at step S7. Here, the degradation degree of a catalyst is judged, and when the detected frequency ratio is larger than a predetermined value, it is judged as that in which the catalyst has deteriorated, and shifts to the degradation detection routine of step S8.

[0031] Although the above control is performed only once immediately after start up (however, after catalytic activity) whenever an engine starts Since momentary degradation of a catalyst is automatically recovered in the condition of having left it in ordinary temperature, it can be considered that the degradation degree (it is called an initial degradation degree below by frequency-ratio Fr:) which degradation recovered while having suspended the engine, therefore was detected to the above-mentioned timing is a thing only reflecting permanent degradation of a catalyst.

[0032] Next, the recovery decision value Tr which is equivalent to the recovery time amount decided according to the degradation degree Rm of the catalyst set as several steps, and the exposure possible time amount Tc which it is in the tolerance of the catalyst engine performance, and can be exposed to exhaust air as it is and a degradation degree from the table shown in drawing 8 based on the reversal frequency ratio Fr at step S11 reads, and it progresses to exposure-time calculation and the recovery routine of step S12 in the degradation detection routine of drawing 5 .

[0033] Since the initial degradation degree Rm which the degradation degree Rm of a catalyst corresponded to the reversal frequency ratio Fr, and was detected immediately after start up supports the permanent degradation degree, in this case, the exposure possible time amount Tc When higher than the value which has an exhaust-gas temperature based on the condition of this permanent degradation, the aggregate value of whenever [catalyst de-activation / which is predicted to go on when operation is continued as it was] is set up as time amount until it reaches the tolerance limit of the catalyst engine performance. And the recovery decision value Tr is set up according to this exposure possible time amount Tc.

[0034] In addition, this routine is repeatedly performed as it is also at a predetermined period, until an engine stops (step S13).

[0035] It is the above mentioned detail of exposure time calculation and a recovery routine, drawing 6 is set to integrated value Tin=0 later mentioned at step S21, and at step S22, as timer

Ti=0, it reads a weighting factor Kc from the table of drawing 9 based on the catalyst inlet-port exhaust-gas temperature T at that time while it starts counting of a timer. This weighting factor expresses whenever [catalyst's which advances to per unit time amount degradation] (this corresponds also to also whenever [recovery]), and strictly, although it serves as a 2-dimensional map which makes a parameter an exhaust-gas temperature and an air-fuel ratio, since the effect of an exhaust-gas temperature is more large, the table set up only based on temperature is sufficient as it.

[0036] The time amount which is in this temperature requirement about an exhaust-gas temperature T at step S23 as compared with the laying temperature range when choosing a weighting factor Kc is integrated at step S24. However, this integrated value Tin increases the integrated value by computing as Tin=Tin+KcxTi and adding a part for multiplication with the time amount Ti when being in the weighting factor Kc and temperature requirement for which it asked based on the exhaust-gas temperature T.

[0037] And if the addition actuation from the above-mentioned step S22 to S25 is repeated, and addition is continued according to the exhaust-gas temperature at that time and an addition result becomes Tin>Tc until it reaches this Tc in this integrated value Tin at step S25 as compared with the exposure possible time amount Tc, it will shift to the catalyst de-activation recovery of drawing 7 .

[0038] Degradation of a catalyst advances according to the time amount exposed to the hot exhaust-gas temperature, is carried out in this way, is relation with the exposure possible time amount Tc, and judges progress of degradation.

[0039] In drawing 7 , in step S26, it resets to integrated value Tin=0 first, the catalyst inlet temperature T judges whether it is an elevated-temperature condition beyond the predetermined value in which degradation recovery is possible at step S27, and a service condition judges further whether it is the rich air-fuel ratio field (KMR) of a heavy load at step S28.

[0040] In this rich air-fuel ratio field, even if it is going to carry out a RIN shift for catalyst de-activation recovery, priority is given to KMR from the point of operability, and since a RIN shift cannot be carried out, progress of the recovery till then is disregarded and it redoes from the beginning.

[0041] It is step S29, and when there is nothing to KMR, as timer Ti=0, counting of a timer is started, and based on the catalyst inlet temperature T, a weighting factor Kr is read, the control factor (for example, a proportion value, an integral value) of feed back control of air-fuel ratio is changed at step S30, the control core of feedback control is shifted to the Lean side, and it shifts to degradation recovery from the table of drawing 9 . In addition, at this time, the quantity of the amount of exhaust air reflux is increased simultaneously, and NO which stopped being able to carry out clarification processing with a three way component catalyst is reduced by air-fuel ratio Lean-ization.

[0042] As mentioned above, except for permanent degradation, as for the palladium system catalyst which deteriorated, recovery of a degraded minute is achieved temporarily because the exhaust-gas temperature which flows into a catalyst Lean-izes an air-fuel ratio in a hot condition.

[0043] The time amount in the condition more than constant temperature is integrated at steps S31 and S32. This integrated value Tim is computed as Tim=Tim+KrxTi. If an exhaust-gas temperature changes from a predetermined temperature requirement at step S31, a timer will be suspended at step S32 and the addition of return and the degradation processing time will be again continued to step S27 via step S33.

[0044] In addition, since recovery of degradation is greatly influenced by the temperature of exhaust air of lean atmosphere also in this case, the weighting factor Kr can be set up from the table of drawing 9 set up only depending on the exhaust-gas temperature.

[0045] At step S33, it judges whether recovery was completed or not by comparing an integrated value Tim with the above mentioned recovery decision value Tr. Thus, if it goes through the recovery time amount corresponding to the degradation degree of the detected catalyst, momentary degradation of a catalyst will be judged to be what was recovered to the initial state (however, a permanent degraded minute removes), will progress to step S34, will return the

control factor and the rate of exhaust air reflux (EGR rate) of feedback control of an air-fuel ratio to the value of the usual operational status, and will end degradation recovery.
[0046] Although an air-fuel ratio is Lean-ized, instead of amending a feedback control multiplier, the equipment which introduces secondary air may be formed in the upstream of a three way component catalyst 1, and the lower stream of a river of an oxygen sensor 2, secondary air may be introduced into the upstream of a catalyst in step S30, and catalyst inflow exhaust air may be Lean-ized. In this case, since an engine air-fuel ratio turns into the usual theoretical air fuel ratio, good operability is securable even if it performs degradation recovery of a catalyst.
[0047] Next, other examples shown in drawing 10 and drawing 11 are explained.
[0048] Since the percentage of completion of degradation of said catalyst related to the permanent degradation degree, i.e., the initial degradation degree detected immediately after engine start up, this example judged the stage until degradation of the whole which doubled degradation and permanent degradation temporarily reaches a tolerance limit based on the reference value according to this degradation degree.
[0049] The routine of drawing 10 is what is performed only once whenever it puts an engine into operation. First, step S41 to the step S46 While it is the same as that of step S1 of the basic routine of drawing 3 - step S6 and memorizing [whenever / degradation / for which it asked from the table of drawing 8 by the reversal frequency ratio Fr in step S47] Rm as Rmo whenever [initial degradation] Based on this Rmo, a reference value Rmc is read from the table of drawing 12 . In this reference value Rmc, Rmc becomes small, so that Rmo+Rmc is decided to become the degradation limit of the catalyst engine performance and Rmo becomes large whenever [initial degradation].
[0050] That is, this degradation degree is memorized as initial degradation here from the degradation judging of a catalyst performed once after engine start up.
[0051] And it shifts to the routine of drawing 10 . This routine is what is repeatedly performed for every predetermined time after engine operation, and judges the percentage of completion of degradation of a catalyst. The step S51 here - step S54 When computing the reversal frequency ratio Fr of an oxygen sensor output in case it is the same, same content even as the above-mentioned step S2 - step S6 and an exhaust-gas temperature is beyond a predetermined value here, at step S55 based on this Fr, reading appearance of the degradation degree Rm is carried out from the table of drawing 8 , and percentage-of-completion deltaRm of degradation is computed the difference of this and said initial degradation degree Rmo, i.e., temporarily, as deltaRm=Rm-Rmo. Since the initial degradation degree detected immediately after an engine's start up corresponds to a permanent degradation degree, this deltaRm expresses momentary degradation of a recoverable catalyst.
[0052] Step S56 compares degradation percentage-of-completion deltaRm with a reference value Rmc temporarily [this]. A reference value Rmc turns into a small value, and the tolerance of degradation also becomes small so much in this case temporarily, so that the initial degradation degree, i.e., a permanent degradation degree, is progressing. When degradation degree deltaRm is not below the reference value Rmc, since it shifts to the recovery routine of a catalyst, it progresses to step S57, and the recovery decision value Tr is read, and recovery actuation of step S58 is performed temporarily.
[0053] In addition, this recovery routine serves as the same activity as step S34 from the above mentioned step S26 of drawing 7 , and performs a period until it reaches the recovery decision value Tr, and degradation recovery of a catalyst by Lean-ization of the air-fuel ratio in an elevated-temperature exhaust air ambient atmosphere.
[0054] Thus, since a stage until degradation of the whole which doubled degradation and permanent degradation temporarily reaches a tolerance limit based on the reference value according to the initial degradation degree detected immediately after engine start up is judged, control for carrying out recovery of the catalyst can be performed efficiently, judging the condition of degradation to accuracy.
[0055]
[Effect of the Invention] The catalyst for exhaust air clarification installed in the engine exhaust air system which the 1st invention made mainly support palladium as a catalyst metal as

mentioned above, A degradation degree detection means to detect the degradation degree of this catalyst, and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst, A degradation recovery stage judging means to judge the stage to perform degradation recovery of a catalyst according to the detected catalyst de-activation degree, Since it had a degradation recovery means to have controlled the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is this judgment result at a degradation recovery stage, and it was detected at it was beyond a predetermined value, if temporary degradation of a catalyst is judged Since Lean control of the exhaust air air-fuel ratio is carried out and recovery of a catalyst is performed when an exhaust-gas temperature is beyond a predetermined value, the always good catalyst engine performance can be maintained and exhaust air emission can be improved.

[0056] The catalyst for exhaust air clarification installed in the engine exhaust air system which the 2nd invention made mainly support palladium as a catalyst metal, A degradation degree detection means to detect the degradation degree of this catalyst, and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst, A degradation recovery stage judging means to judge the stage to perform degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery time setting means to set up the time amount which performs degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery means to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is said judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value, Since it had a degradation recovery termination means to terminate degradation recovery when the degradation recovery time amount to which the addition time amount after shifting to this degradation recovery was set was reached, Since it decides on time amount required for degradation recovery according to the degradation degree of a catalyst and only this setup time performs recovery, effect which exerts an air-fuel ratio on the operability accompanying degradation recovery and the exhaust air engine performance which are Lean-ized is lessened as much as possible, and recovery of a catalyst can be carried out efficiently.

[0057] The 3rd invention is set to the 1st or 2nd invention. Said degradation recovery stage judging means An exposure possible time amount presumption means to presume time amount when a catalyst is exposed to the exhaust air beyond predetermined temperature, until a degradation degree advances across tolerance based on the detection value of the catalyst de-activation degree immediately after engine start up, Since the detected exhaust-gas temperature consists of comparison test means to compare an exposure time addition means to integrate the time amount which is beyond a predetermined value with the exposure possible time amount presumed to be the integrated exposure time, and to judge a degradation recovery stage A degradation recovery stage can be judged to accuracy by presuming time amount until degradation arrives at tolerance temporarily according to extent of permanent degradation of a catalyst.

[0058] A storage means by which the 4th invention memorizes the degradation degree which the degradation degree detection means detected [said degradation recovery stage judging means] just behind engine start up as an initial degradation degree in the 1st or 2nd invention, A degradation percentage-of-completion calculation means to compute the difference of the degradation degree and initial degradation degree which were detected for every predetermined time, Since it consists of comparison test means to compare this degradation percentage of completion with the reference value set up according to an initial degradation degree, and to judge a degradation recovery stage By measuring the degradation percentage of completion of a catalyst with an initial degradation degree, a stage until degradation of the whole which doubled degradation and permanent degradation temporarily arrives at tolerance can be judged to accuracy.

[0059] Since said degradation recovery means amends a feedback control multiplier in case the

5th invention carries out feedback control of an engine's air-fuel ratio to theoretical air fuel ratio in the 1st - the 4th invention and shifts an air-fuel ratio to the Lean side, although it Lean-izes an air-fuel ratio for degradation processing, the addition of a new hard configuration is unnecessary, and a configuration is simplified.

[0060] In the 1st - the 4th invention, since said degradation recovery means introduces secondary air into the upstream of the catalyst installed in the flueway, and shifts the air-fuel ratio of catalyst inflow exhaust air to the Lean side and an engine's air-fuel ratio has it in the usual control range even if it Lean-izes an air-fuel ratio for degradation recovery, the 6th invention can secure good operability also in degradation recovery.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to an internal combustion engine's exhaust emission control device.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

PRIOR ART

[Description of the Prior Art] While carrying out feedback control of the air-fuel ratio so that it may become theoretical air fuel ratio in order to defecate the exhaust gas discharged by the internal combustion engine, the system which installed in the flueway the three way component catalyst which performs oxidation of HC and CO and reduction of NO simultaneously is put in practical use widely.
[0003] What used as the principal component the palladium excellent in low-temperature activity which functions good [from] among short time after engine start up as a catalyst metal used for this three way component catalyst is developed (refer to JP,58-189037,A).
[0004] Oxide of palladium (Pd) is stable in ordinary temperature, and it demonstrates a catalysis as oxidization palladium (PdO).

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The catalyst for exhaust air clarification installed in the engine exhaust air system which made palladium mainly support with the 1st invention as a catalyst metal as mentioned above, A degradation degree detection means to detect the degradation degree of this catalyst, and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst, A degradation recovery stage judging means to judge the stage to perform degradation recovery of a catalyst according to the detected catalyst de-activation degree, Since it had a degradation recovery means to have controlled the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is this judgment result at a degradation recovery stage, and it was detected at it was beyond a predetermined value, if temporary degradation of a catalyst is judged When an exhaust-gas temperature is beyond a predetermined value, Lean control of the exhaust air air-fuel ratio is carried out, and recovery of a catalyst is performed. Therefore, the always good catalyst engine performance can be maintained and exhaust air emission can be improved.
[0056] The catalyst for exhaust air clarification installed in the engine exhaust air system which made palladium mainly support with the 2nd invention as a catalyst metal, A degradation degree detection means to detect the degradation degree of this catalyst, and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst, A degradation recovery stage judging means to judge the stage to perform degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery time setting means to set up the time amount which performs degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery means to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is said judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value, Since it had a degradation recovery termination means to terminate degradation recovery when the degradation recovery time amount to which the addition time amount after shifting to this degradation recovery was set was reached, according to the degradation degree of a catalyst, it decides on time amount required for degradation recovery, and only this setup time performs recovery. Therefore, effect which exerts an air-fuel ratio on the operability accompanying degradation recovery and the exhaust air engine performance which are Lean-ized is lessened as much as possible, and recovery of a catalyst can be carried out efficiently.
[0057] In the 3rd invention, it sets to the 1st or 2nd invention. Said degradation recovery stage judging means An exposure possible time amount presumption means to presume time amount when a catalyst is exposed to the exhaust air beyond predetermined temperature, until a degradation degree advances across tolerance based on the detection value of the catalyst de-activation degree immediately after engine start up, The detected exhaust-gas temperature consists of comparison test means to compare an exposure time addition means to integrate the time amount which is beyond a predetermined value with the exposure possible time amount presumed to be the integrated exposure time, and to judge a degradation recovery stage.

Therefore, a degradation recovery stage can be judged to accuracy by presuming time amount until degradation arrives at tolerance temporarily according to extent of permanent degradation of a catalyst.

[0058] A storage means by which said degradation recovery stage judging means memorizes the degradation degree which the degradation degree detection means detected immediately after engine start up as an initial degradation degree in the 1st or 2nd invention in the 4th invention, It consists of comparison test means to compare a degradation percentage-of-completion calculation means to compute the difference of the degradation degree and initial degradation degree which were detected for every predetermined time with this degradation percentage of completion and the reference value set up according to an initial degradation degree, and to judge a degradation recovery stage. Therefore, a stage until degradation of the whole which doubled degradation and permanent degradation temporarily arrives at tolerance can be judged to accuracy by measuring the degradation percentage of completion of a catalyst with an initial degradation degree.

[0059] Since said degradation recovery means amends a feedback control multiplier in case the 5th invention carries out feedback control of an engine's air-fuel ratio to theoretical air fuel ratio in the 1st - the 4th invention and shifts an air-fuel ratio to the Lean side, although it Lean-izes an air-fuel ratio for degradation processing, the addition of a new hard configuration is unnecessary, and a configuration is simplified.

[0060] In the 1st - the 4th invention, since said degradation recovery means introduces secondary air into the upstream of the catalyst installed in the flueway, and shifts the air-fuel ratio of catalyst inflow exhaust air to the Lean side and an engine's air-fuel ratio has it in the usual control range even if it Lean-izes an air-fuel ratio for degradation recovery, the 6th invention can secure good operability also in degradation recovery.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, if a palladium system catalyst is an air-fuel ratio by the side of rich and is exposed to a hot exhaust air ambient atmosphere rather than theoretical air fuel ratio, it will be returned to metal palladium and it will cause degradation temporarily [so-called] the catalyst engine performance falls temporarily. Degradation appears temporarily [this] notably [the catalyst to which permanent degradation which breaks out by reduction of the specific surface area by heat deformation of a wash coat, reduction of degree of dispersion of noble metals, etc. progressed].
[0006] If momentary degradation of a catalyst breaks out, the cleaning effect of exhaust air will fall and exhaust air emission will increase in the meantime.
[0007] Then, when degradation is caused in this way temporarily, this invention performs degradation recovery of a catalyst and aims at recovering the catalyst engine performance.

[Translation done.]

MEANS

[Means for Solving the Problem] The catalyst for exhaust air clarification with which the 1st invention is installed in the engine exhaust air system which made palladium mainly support as a catalyst metal as shown in drawing 14 (1), A degradation degree detection means 51 to detect the degradation degree of this catalyst (1), and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst (1) (13), A degradation recovery stage judging means 52 to judge the stage to perform degradation recovery of a catalyst (1) according to the detected catalyst de-activation degree, When the exhaust-gas temperature with which there is this judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value, it has a degradation recovery means 53 to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst (1).
[0009] The catalyst for exhaust air clarification with which the 2nd invention is installed in the engine exhaust air system which made palladium mainly support as a catalyst metal as shown in drawing 15 (1), A degradation degree detection means 51 to detect the degradation degree of this catalyst (1), and an exhaust-gas-temperature detection means to detect the exhaust-gas temperature which flows into a catalyst (1) (13), A degradation recovery stage judging means 52 to judge the stage to perform degradation recovery of a catalyst (1) according to the detected catalyst de-activation degree, A degradation recovery time setting means 54 to set up the time amount which performs degradation recovery of a catalyst according to the detected catalyst de-activation degree, A degradation recovery means 53 to control the air-fuel ratio of exhaust air rather than theoretical air fuel ratio to the degradation recovery air-fuel ratio by the side of Lean, and to perform degradation recovery of a catalyst when the exhaust-gas temperature with which there is said judgment result at a degradation recovery stage, and it was detected at it is beyond a predetermined value, When the degradation recovery time amount to which the addition time amount after shifting to this degradation recovery was set is reached, it has a degradation recovery termination means 55 to terminate degradation recovery.
[0010] The 3rd invention is set to the 1st or 2nd invention. Said degradation recovery stage judging means An exposure possible time amount presumption means to presume time amount when a catalyst is exposed to the exhaust air beyond predetermined temperature, until a degradation degree advances across tolerance based on the detection value of the catalyst de-activation degree immediately after engine start up, This detected exhaust-gas temperature consists of comparison test means to compare an exposure time addition means to integrate the time amount which is beyond a predetermined value with the exposure possible time amount presumed to be the integrated exposure time, and to judge a degradation recovery stage.
[0011] A storage means by which the 4th invention memorizes the degradation degree which the degradation degree detection means detected [said degradation recovery stage judging means] just behind engine start up as an initial degradation degree in the 1st or 2nd invention, It consists of comparison test means to compare a degradation percentage-of-completion calculation means to compute the difference of the degradation degree and initial degradation degree which were detected for every predetermined time with this degradation percentage of completion and the reference value set up according to an initial degradation degree, and to judge a degradation

recovery stage.
[0012] In the 1st – the 4th invention, said degradation recovery means amends the feedback control multiplier when carrying out feedback control of an engine's air-fuel ratio to theoretical air fuel ratio, and the 5th invention shifts an air-fuel ratio to the Lean side.
[0013] In the 1st – the 4th invention, said degradation recovery means introduces secondary air into the upstream of the catalyst installed in the flueway, and the 6th invention shifts the air-fuel ratio of catalyst inflow exhaust air to the Lean side.

[Translation done.]

EXAMPLE

[Example] Drawing 1 shows the example of this invention and a fuel injection valve 5 injects a fuel according to a mounting eclipse and the signal from a controller 4 in the inhalation-of-air path 8 of an engine 7. The three way component catalyst 1 which performs simultaneously HC under exhaust air, oxidation of CO, and reduction of NO is installed in a flueway 9. This three way component catalyst 1 is constituted from a palladium system catalyst which made palladium (Pd) mainly support Seria etc. as a catalyst metal in addition to this by the alumina.
[0022] The 1st and 2nd oxygen sensor 2 and 3 is installed in the upstream and the lower stream of a river of a three way component catalyst 1, respectively, and the controller 4 is carrying out feedback control of said fuel injection volume so that an air-fuel ratio may turn into theoretical air fuel ratio based on the output of the 1st oxygen sensor 2. Moreover, the degradation degree of a catalyst is detected and degradation recovery of a catalyst is performed at a predetermined operation stage corresponding to this degradation so that the output of the 1st oxygen sensor 2 and the 2nd oxygen sensor 3 may measure and mention later the count reversed to Rich Lean, respectively. In addition, for this reason, the signal from the coolant temperature sensor 12 which detects engine-cooling-water **, and the temperature sensor 13 which detects the exhaust-gas temperature of the entrance side of a three way component catalyst 1 inputs into a controller 4. Moreover, although not illustrated, the signal representing operational status, such as an engine inhalation air content and a rotational frequency, is also inputted.
[0023] In addition, the exhaust air reflux path 14 which flows back the exhaust air from [a part of] a flueway 9 is connected to the inhalation-of-air path 8, the exhaust air reflux control valve 15 controls the amount of reflux of exhaust air according to a service condition through a controller 4, and NO under exhaust air is decreased.
[0024] As shown also in drawing 2 , the palladium system catalyst has the property that the catalyst engine performance deteriorates temporarily, by exposing in theoretical air fuel ratio or an elevated-temperature exhaust air ambient atmosphere more rich than it. Moreover, it generates like the catalyst also with common permanent degradation accompanying physical degradation of a catalyst apart from this. Temperature is 500 degrees C and what was illustrated expresses the condition (momentary degradation) of change of a catalyst invert ratio when an air-fuel ratio exposes a rear-spring-supporter palladium system catalyst to long duration at elevated-temperature exhaust air of theoretical air fuel ratio (lambda= 1). In this case, although the catalyst invert ratio falls with the passage of time, the catalyst A with little permanent degradation has little change, on the other hand, in Catalysts B and C and the thing to which permanent degradation progressed, decline in an invert ratio appears notably. About momentary degradation of a catalyst, it can recover in the elevated-temperature exhaust air ambient atmosphere of the Lean air-fuel ratio, and the catalyst engine performance is recovered to the condition of the beginning of permanent degradation, respectively. Therefore, if the condition of momentary degradation of a catalyst is judged, it will be the service condition from which an exhaust-gas temperature serves as an elevated temperature, and the catalyst which deteriorated will be recovered by controlling an air-fuel ratio to Lean temporarily.
[0025] In order to perform degradation recovery of such a catalyst, a controller 4 performs control shown in drawing 3 - drawing 9 .

[0026] First, drawing 3 is a control routine for judging degradation of a catalyst, and is performed only once after an engine's start up.
[0027] If the engine cooling water temperature Tw is read at step S1, it will judge whether the cooling water temperature Tw judges whether it is more than predetermined value T1 of for example, an after [warming-up termination], and, subsequently to the feedback control field of an air-fuel ratio, there is at step S3 at step S2. [any]
[0028] In addition, when all differ, it returns first.
[0029] In step S4 and 5, the reversal frequencies F1 and F2 of Rich Lean of the output of the 1st oxygen sensor 2 of the catalyst upstream and the 2nd down-stream oxygen sensor 3 are read, respectively. The ratio of a reversal frequency and F2/F1 approach 1, so that the degradation degree of a catalyst progresses, as shown in drawing 4 . Since storage of the oxygen under exhaust air is carried out while the catalyst is functioning normally, the oxygen contained during upstream exhaust air is undetectable as it is on the lower stream of a river of a catalyst. However, if a catalyst deteriorates, in order [to which the oxygen under upstream exhaust air flows down-stream as it is] to come out, the reversal frequency of a down-stream oxygen sensor output will approach the reversal frequency of an upstream oxygen sensor output.
[0030] In step S6, this reversal frequency ratio Fr is computed as F2/F1, and this frequency ratio Fr is compared with the predetermined value Fra at step S7. Here, the degradation degree of a catalyst is judged, and when the detected frequency ratio is larger than a predetermined value, it is judged as that in which the catalyst has deteriorated, and shifts to the degradation detection routine of step S8.
[0031] Although the above control is performed only once immediately after start up (however, after catalytic activity) whenever an engine starts Since momentary degradation of a catalyst is automatically recovered in the condition of having left it in ordinary temperature, it can be considered that the degradation degree (it is called an initial degradation degree below by frequency-ratio Fr:) which degradation recovered while having suspended the engine, therefore was detected to the above-mentioned timing is a thing only reflecting permanent degradation of a catalyst.
[0032] Next, the recovery decision value Tr which is equivalent to the recovery time amount decided according to the degradation degree Rm of the catalyst set as several steps, and the exposure possible time amount Tc which it is in the tolerance of the catalyst engine performance, and can be exposed to exhaust air as it is and a degradation degree from the table shown in drawing 8 based on the reversal frequency ratio Fr at step S11 reads, and it progresses to exposure-time calculation and the recovery routine of step S12 in the degradation detection routine of drawing 5 .
[0033] Since the initial degradation degree Rm which the degradation degree Rm of a catalyst corresponded to the reversal frequency ratio Fr, and was detected immediately after start up supports the permanent degradation degree, in this case, the exposure possible time amount Tc When higher than the value which has an exhaust-gas temperature based on the condition of this permanent degradation, the aggregate value of whenever [catalyst de-activation / which is predicted to go on when operation is continued as it was] is set up as time amount until it reaches the tolerance limit of the catalyst engine performance. And the recovery decision value Tr is set up according to this exposure possible time amount Tc.
[0034] In addition, this routine is repeatedly performed as it is also at a predetermined period, until an engine stops (step S13).
[0035] It is the above mentioned detail of exposure time calculation and a recovery routine, drawing 6 is set to integrated value Tin=0 later mentioned at step S21, and at step S22, as timer Ti=0, it reads a weighting factor Kc from the table of drawing 9 based on the catalyst inlet-port exhaust-gas temperature T at that time while it starts counting of a timer. This weighting factor expresses whenever [catalyst's which advances to per unit time amount degradation] (this corresponds also to also whenever [recovery]), and strictly, although it serves as a 2-dimensional map which makes a parameter an exhaust-gas temperature and an air-fuel ratio, since the effect of an exhaust-gas temperature is more large, the table set up only based on temperature is sufficient as it.

[0036] The time amount which is in this temperature requirement about an exhaust-gas temperature T at step S23 as compared with the laying temperature range when choosing a weighting factor Kc is integrated at step S24. However, this integrated value Tin increases the integrated value by computing as Tin=Tin+KcxTi and adding a part for multiplication with the time amount Ti when being in the weighting factor Kc and temperature requirement for which it asked based on the exhaust-gas temperature T.
[0037] And if the addition actuation from the above-mentioned step S22 to S25 is repeated, and addition is continued according to the exhaust-gas temperature at that time and an addition result becomes Tin>Tc until it reaches this Tc in this integrated value Tin at step S25 as compared with the exposure possible time amount Tc, it will shift to the catalyst de-activation recovery of drawing 7 .
[0038] Degradation of a catalyst advances according to the time amount exposed to the hot exhaust-gas temperature, is carried out in this way, is relation with the exposure possible time amount Tc, and judges progress of degradation.
[0039] In drawing 7 , in step S26, it resets to integrated value Tin=0 first, the catalyst inlet temperature T judges whether it is an elevated-temperature condition beyond the predetermined value in which degradation recovery is possible at step S27, and a service condition judges further whether it is the rich air-fuel ratio field (KMR) of a heavy load at step S28.
[0040] In this rich air-fuel ratio field, even if it is going to carry out a RIN shift for catalyst de-activation recovery, priority is given to KMR from the point of operability, and since a RIN shift cannot be carried out, progress of the recovery till then is disregarded and it redoes from the beginning.
[0041] It is step S29, and when there is nothing to KMR, as timer Ti=0, counting of a timer is started, and based on the catalyst inlet temperature T, a weighting factor Kr is read, the control factor (for example, a proportion value, an integral value) of feed back control of air-fuel ratio is changed at step S30, the control core of feedback control is shifted to the Lean side, and it shifts to degradation recovery from the table of drawing 9 . In addition, at this time, the quantity of the amount of exhaust air reflux is increased simultaneously, and NO which stopped being able to carry out clarification processing with a three way component catalyst is reduced by air-fuel ratio Lean-ization.
[0042] As mentioned above, except for permanent degradation, as for the palladium system catalyst which deteriorated, recovery of a degraded minute is achieved temporarily because the exhaust-gas temperature which flows into a catalyst Lean-izes an air-fuel ratio in a hot condition.
[0043] The time amount in the condition more than constant temperature is integrated at steps S31 and S32. This integrated value Tim is computed as Tim=Tim+KrxTi. If an exhaust-gas temperature changes from a predetermined temperature requirement at step S31, a timer will be suspended at step S32 and the addition of return and the degradation processing time will be again continued to step S27 via step S33.
[0044] In addition, since recovery of degradation is greatly influenced by the temperature of exhaust air of lean atmosphere also in this case, the weighting factor Kr can be set up from the table of drawing 9 set up only depending on the exhaust-gas temperature.
[0045] At step S33, it judges whether recovery was completed or not by comparing an integrated value Tim with the above mentioned recovery decision value Tr. Thus, if it goes through the recovery time amount corresponding to the degradation degree of the detected catalyst, momentary degradation of a catalyst will be judged to be what was recovered to the initial state (however, a permanent degraded minute removes), will progress to step S34, will return the control factor and the rate of exhaust air reflux (EGR rate) of feedback control of an air-fuel ratio to the value of the usual operational status, and will end degradation recovery.
[0046] Although an air-fuel ratio is Lean-ized, instead of amending a feedback control multiplier, the equipment which introduces secondary air may be formed in the upstream of a three way component catalyst 1, and the lower stream of a river of an oxygen sensor 2, secondary air may be introduced into the upstream of a catalyst in step S30, and catalyst inflow exhaust air may be Lean-ized. In this case, since an engine air-fuel ratio turns into the usual theoretical air fuel

ratio, good operability is securable even if it performs degradation recovery of a catalyst.
[0047] Next, other examples shown in drawing 10 and drawing 11 are explained.
[0048] Since the percentage of completion of degradation of said catalyst related to the permanent degradation degree, i.e., the initial degradation degree detected immediately after engine start up, this example judged the stage until degradation of the whole which doubled degradation and permanent degradation temporarily reaches a tolerance limit based on the reference value according to this degradation degree.
[0049] The routine of drawing 10 is what is performed only once whenever it puts an engine into operation. First, step S41 to the step S46 While it is the same as that of step S1 of the basic routine of drawing 3 - step S6 and memorizing [whenever / degradation / for which it asked from the table of drawing 8 by the reversal frequency ratio Fr in step S47] Rm as Rmo whenever [initial degradation] Based on this Rmo, a reference value Rmc is read from the table of drawing 12 . In this reference value Rmc, Rmc becomes small, so that Rmo+Rmc is decided to become the degradation limit of the catalyst engine performance and Rmo becomes large whenever [initial degradation].
[0050] That is, this degradation degree is memorized as initial degradation here from the degradation judging of a catalyst performed once after engine start up.
[0051] And it shifts to the routine of drawing 10 . This routine is what is repeatedly performed for every predetermined time after engine operation, and judges the percentage of completion of degradation of a catalyst. The step S51 here - step S54 When computing the reversal frequency ratio Fr of an oxygen sensor output in case it is the same, same content even as the above-mentioned step S2 - step S6 and an exhaust-gas temperature is beyond a predetermined value here, at step S55 based on this Fr, reading appearance of the degradation degree Rm is carried out from the table of drawing 8 , and percentage-of-completion deltaRm of degradation is computed the difference of this and said initial degradation degree Rmo, i.e., temporarily, as deltaRm=Rm-Rmo. Since the initial degradation degree detected immediately after an engine's start up corresponds to a permanent degradation degree, this deltaRm expresses momentary degradation of a recoverable catalyst.
[0052] Step S56 compares degradation percentage-of-completion deltaRm with a reference value Rmc temporarily [this]. A reference value Rmc turns into a small value, and the tolerance of degradation also becomes small so much in this case temporarily, so that the initial degradation degree, i.e., a permanent degradation degree, is progressing. When degradation degree deltaRm is not below the reference value Rmc, since it shifts to the recovery routine of a catalyst, it progresses to step S57, and the recovery decision value Tr is read, and recovery actuation of step S58 is performed temporarily.
[0053] In addition, this recovery routine serves as the same activity as step S34 from the above mentioned step S26 of drawing 7 , and performs a period until it reaches the recovery decision value Tr, and degradation recovery of a catalyst by Lean-ization of the air-fuel ratio in an elevated-temperature exhaust air ambient atmosphere.
[0054] Thus, since a stage until degradation of the whole which doubled degradation and permanent degradation temporarily reaches a tolerance limit based on the reference value according to the initial degradation degree detected immediately after engine start up is judged, control for carrying out recovery of the catalyst can be performed efficiently, judging the condition of degradation to accuracy.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram showing the example of this invention.
[Drawing 2] It is the explanatory view showing the changes condition of the catalyst engine performance.
[Drawing 3] It is the flow chart which shows the control action of degradation detection of the catalyst of the above-mentioned example.
[Drawing 4] Similarly it is the explanatory view of a degradation judging of a catalyst.
[Drawing 5] It is the flow chart which similarly shows the control action of a degradation judging of a catalyst.
[Drawing 6] It is the flow chart which similarly shows the control action of exposure time setting out of a catalyst.
[Drawing 7] It is the flow chart which similarly shows the control action of degradation recovery.
[Drawing 8] It is the explanatory view showing relation, such as a reversal frequency ratio and a degradation degree.
[Drawing 9] It is the explanatory view showing the relation between catalyst inlet temperature and a weighting factor.
[Drawing 10] It is the flow chart which shows the control action of other examples.
[Drawing 11] Similarly it is the flow chart of the control action of a degradation progress judging of a catalyst.
[Drawing 12] It is the explanatory view showing the relation between whenever [initial degradation], and a reference value.
[Drawing 13] It is the explanatory view showing the relation between the degradation percentage of completion and a recovery decision value.
[Drawing 14] It is the block diagram of the 1st invention.
[Drawing 15] It is the block diagram of the 2nd invention.
[Description of Notations]
1 Three Way Component Catalyst (Palladium System Catalyst)
2 Oxygen Sensor
3 Oxygen Sensor
4 Controller
5 Fuel Injection Valve
9 Flueway
13 Exhaust-gas-Temperature Sensor
51 Degradation Degree Detection Means
52 Degradation Recovery Stage Judging Means
53 Degradation Recovery Means
54 Degradation Recovery Time Setting Means
55 Degradation Recovery Termination Means

[Translation done.]

* NOTICES *

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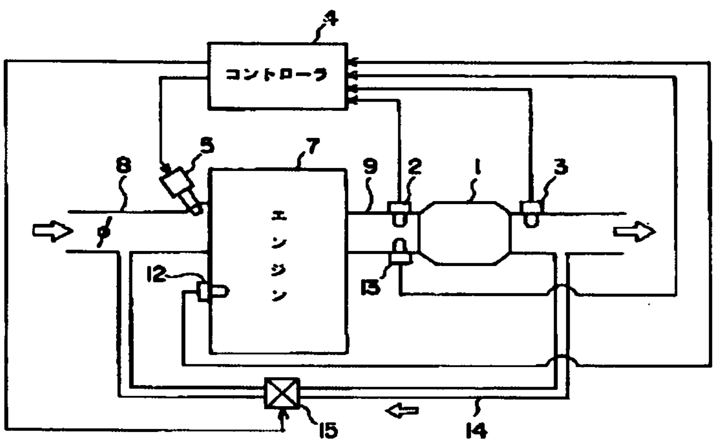
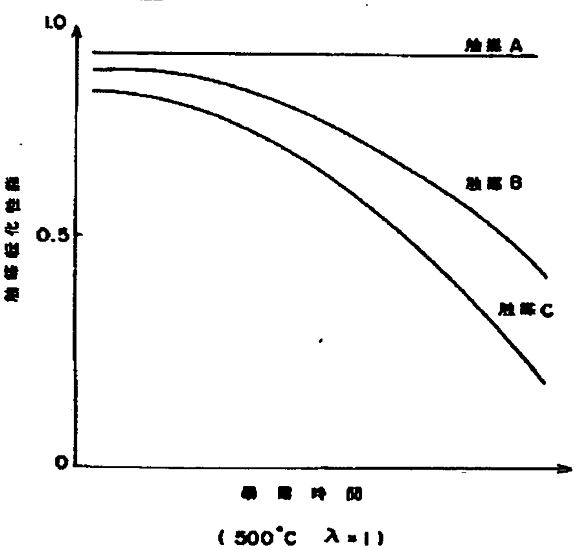
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

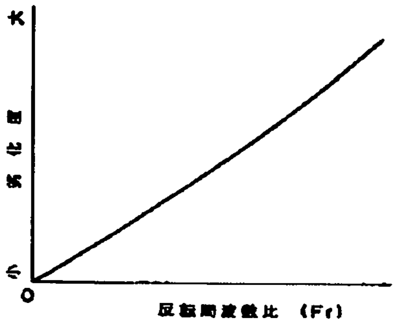
[Drawing 1]



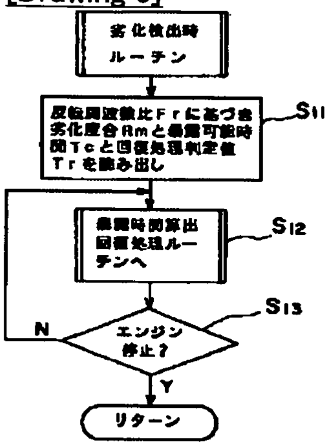
[Drawing 2]



[Drawing 4]



[Drawing 5]



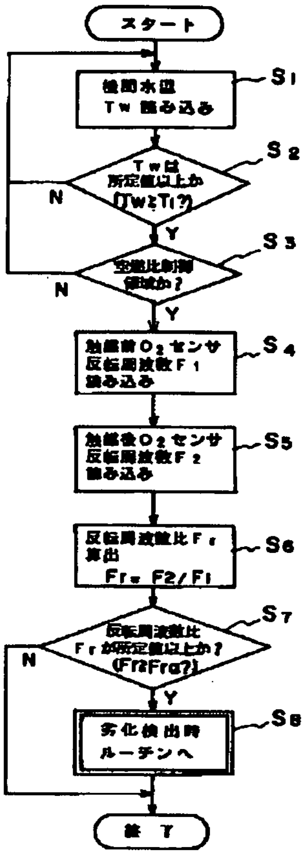
[Drawing 8]

反転周波数比	Fr	Fr_1	Fr_2	....	Fr_ℓ
劣化度合	Rm	Rm_1	Rm_2	....	Rm_ℓ
暴露可能時間	Tc	Tc_1	Tc_2	....	Tc_ℓ
回復処理判定値	Tr	Tr_1	Tr_2	....	Tr_ℓ

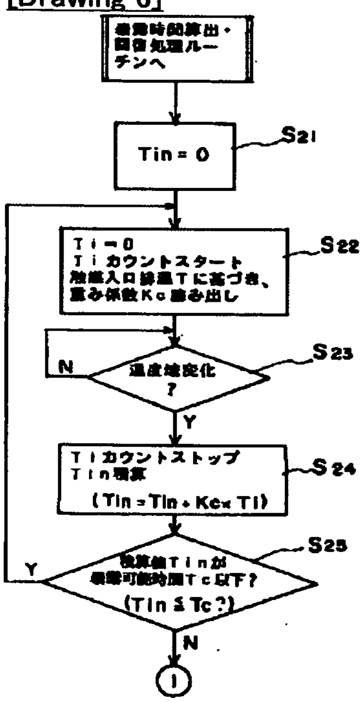
[Drawing 9]

触媒入口排温	T	T_1	T_2	....	Tm
重み係数	Kc	Kc_1	Kc_2	....	Kcm
重み係数	Kr	Kr_1	Kr_2	....	Krm

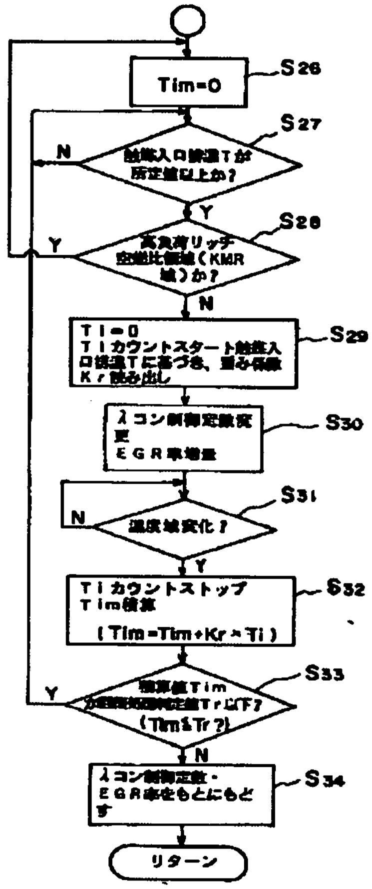
[Drawing 3]



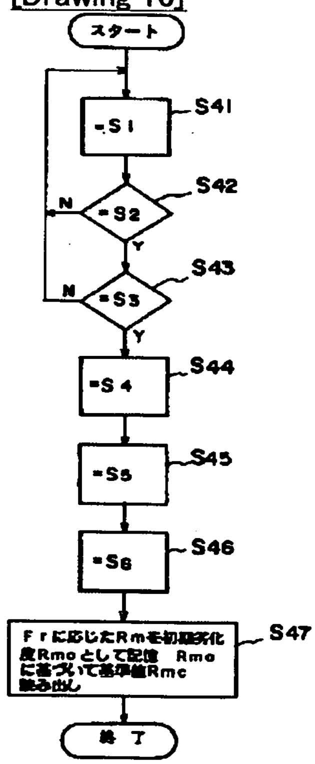
[Drawing 6]



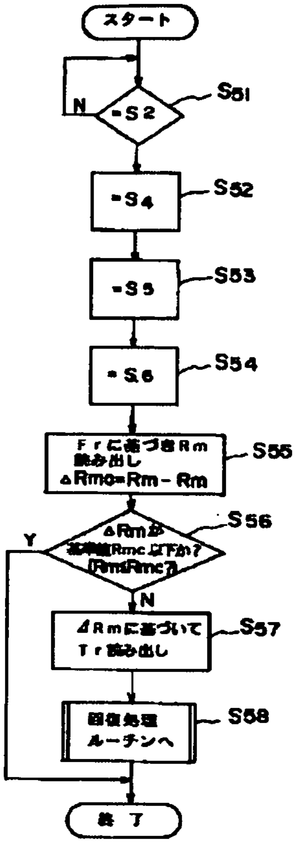
[Drawing 7]



[Drawing 10]



[Drawing 11]



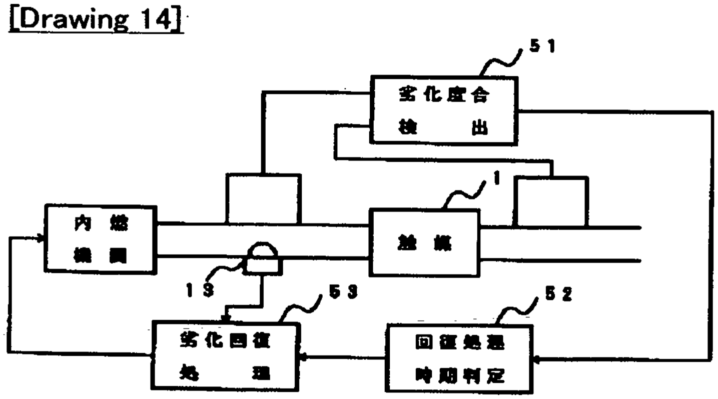
[Drawing 12]

初期劣化度 Rmo	Rmo 1	Rmo 2		Rmo ℓ
基準値 Rmc	Rmc 1	Rmc 2		Rmc ℓ

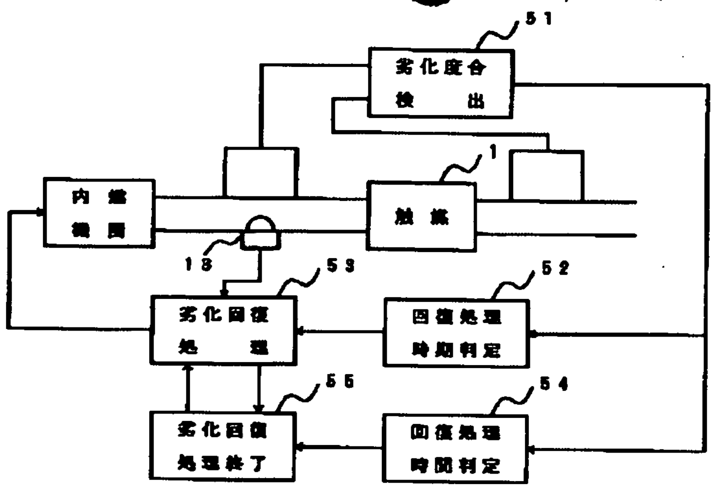
[Drawing 13]

劣化進行度 ΔRm	ΔRm1	ΔRm2		ΔRmℓ
回復処理判定値 Tr	Tr1	Tr2		Trℓ

[Drawing 14]



[Drawing 15]



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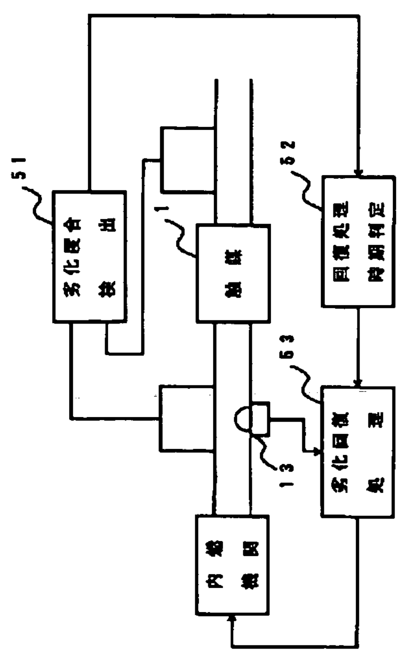
(54)【発明の名称】　内燃機関の排気浄化装置

(57)【要約】
【目的】　触媒が一時劣化を起こしたら、回復処理を施し、触媒性能を回復させる。
【構成】　触媒金属として主にパラジウムを担持させた機関排気系に設置される排気浄化用の触媒（１）と、触媒（１）の劣化度合を検出する劣化度合検出手段５１と、触媒（１）に流入する排気温度を検出する排気温度検出手段（１３）と、検出された触媒劣化度合に応じて触媒（１）の劣化回復処理を行う時期を判定する手段５２と、判定結果が劣化回復処理時期にありかつ検出された排気温度が所定値以上であるときに排気の空燃比を理論空燃比よりもリーン側の劣化回復処理空燃比に制御して触媒（１）の劣化回復処理を行う手段５３とを備える。



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【特許請求の範囲】

【請求項1】触媒金属として主にパラジウムを担持させた機関排気系に設置される排気浄化用の触媒と、
この触媒の劣化度合を検出する劣化度合検出手段と、
触媒に流入する排気温度を検出する排気温度検出手段と、
検出された触媒劣化度合に応じて触媒の劣化回復処理を行う時期を判定する劣化回復処理時期判定手段と、
この判定結果が劣化回復処理時期にありかつ検出された排気温度が所定値以上であるときに排気の空燃比を理論空燃比よりもリーン側の劣化回復処理空燃比に制御して触媒の劣化回復処理を行う劣化回復処理手段とを備えることを特徴とする内燃機関の排気浄化装置。

【請求項2】触媒金属として主にパラジウムを担持させた機関排気系に設置される排気浄化用の触媒と、
この触媒の劣化度合を検出する劣化度合検出手段と、
触媒に流入する排気温度を検出する排気温度検出手段と、
検出された触媒劣化度合に応じて触媒の劣化回復処理を行う時期を判定する劣化回復処理時期判定手段と、
検出された触媒劣化度合に応じて触媒の劣化回復処理を行う時間を設定する劣化回復処理時間設定手段と、
前記判定結果が劣化回復処理時期にありかつ検出された排気温度が所定値以上であるときに排気の空燃比を理論空燃比よりもリーン側の劣化回復処理空燃比に制御して触媒の劣化回復処理を行う劣化回復処理手段と、
この劣化回復処理に移行してからの積算時間が設定された劣化回復処理時間に達したときに劣化回復処理を終了させる劣化回復処理終了手段とを備えることを特徴とする内燃機関の排気浄化装置。

【請求項3】前記劣化回復処理時期判定手段が、機関始動直後の触媒劣化度合の検出値に基づいて、触媒を所定温度以上の排気に晒したときに劣化度合が許容範囲を越えて進行するまでの時間を推定する暴露可能時間推定手段と、
この検出された排気温度が所定値以上である時間を積算する暴露時間積算手段と、
積算された暴露時間と推定された暴露可能時間とを比較して劣化回復処理時期を判定する比較判定手段とから構成される請求項1または2に記載の内燃機関の排気浄化装置。

【請求項4】前記劣化回復処理時期判定手段が、機関始動直後に劣化度合検出手段が検出した劣化度合を初期劣化度合として記憶する記憶手段と、
所定時間毎に検出した劣化度合と初期劣化度合との差を算出する劣化進行度算出手段と、
この劣化進行度と初期劣化度合に応じて設定される基準値とを比較して劣化回復処理時期を判定する比較判定手段とから構成される請求項1または2に記載の内燃機関の排気浄化装置。

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【請求項5】前記劣化回復処理手段は、機関の空燃比を理論空燃比にフィードバック制御するときのフィードバック制御係数を補正して空燃比をリーン側にシフトさせる請求項1～4のいずれか一つに記載の内燃機関の排気浄化装置。

【請求項6】前記劣化回復処理手段は、排気通路に設置した触媒の上流に2次空気を導入して触媒流入排気の空燃比をリーン側にシフトさせる請求項1～4のいずれか一つに記載の内燃機関の排気浄化装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は内燃機関の排気浄化装置に関する。

【0002】

【従来の技術】内燃機関から排出される排気ガスを清浄化するため、空燃比を理論空燃比となるようにフィードバック制御すると共に、排気通路にHC，COの酸化と、NOの還元を同時に行う三元触媒を設置したシステムが、広く実用化されている。

【0003】この三元触媒に用いられる触媒金属として、機関始動後、短時間のうちから良好に機能する、低温活性にすぐれているパラジウムを主成分としたものが開発されている（特開昭58－189037号公報参照）。

【0004】パラジウム（Pd）は常温で酸化物が安定で、酸化パラジウム（PdO）として触媒作用を発揮する。

【0005】

【発明が解決しようとする課題】ところで、パラジウム系触媒は、理論空燃比よりもリッチ側の空燃比で、高温の排気雰囲気に晒されると、金属パラジウムに還元されてしまい、触媒性能が一時的に低下する、いわゆる一時劣化を起こす。この一時劣化は、ウォッシュコートの熱変形による比表面積の減少や、貴金属の分散度の減少等によって起きる永久劣化が進んだ触媒ほど、顕著に現れる。

【0006】触媒の一時劣化が起きれば、その間、排気の浄化作用が低下し、排気エミッションが増加する。

【0007】そこで、本発明は、このように一時劣化を起こした場合に、触媒の劣化回復処理を施し、触媒性能を回復させることを目的とする。

【0008】

【課題を解決するための手段】第1の発明は、図14に示すように、触媒金属として主にパラジウムを担持させた機関排気系に設置される排気浄化用の触媒（1）と、この触媒（1）の劣化度合を検出する劣化度合検出手段51と、触媒（1）に流入する排気温度を検出する排気温度検出手段（13）と、検出された触媒劣化度合に応じて触媒（1）の劣化回復処理を行う時期を判定する劣化回復処理時期判定手段52と、この判定結果が劣化回復

復処理時期にありかつ検出された排気温度が所定値以上であるときに排気の空燃比を理論空燃比よりもリーン側の劣化回復処理空燃比に制御して触媒（1）の劣化回復処理を行う劣化回復処理手段53とを備える。

【0009】第2の発明は、図15に示すように、触媒金属として主にパラジウムを担持させた機関排気系に設置される排気浄化用の触媒（1）と、この触媒（1）の劣化度合を検出する劣化度合検出手段51と、触媒（1）に流入する排気温度を検出する排気温度検出手段（13）と、検出された触媒劣化度合に応じて触媒（1）の劣化回復処理を行う時期を判定する劣化回復処理時期判定手段52と、検出された触媒劣化度合に応じて触媒の劣化回復処理を行う時間を設定する劣化回復処理時間設定手段54と、前記判定結果が劣化回復処理時期にありかつ検出された排気温度が所定値以上であるときに排気の空燃比を理論空燃比よりもリーン側の劣化回復処理空燃比に制御して触媒の劣化回復処理を行う劣化回復処理手段53と、この劣化回復処理に移行してからの積算時間が設定された劣化回復処理時間に達したときに劣化回復処理を終了させる劣化回復処理終了手段55とを備える。

【0010】第3の発明は、第1または第2の発明において、前記劣化回復処理時期判定手段が、機関始動直後の触媒劣化度合の検出値に基づいて、触媒を所定温度以上の排気に晒したときに劣化度合が許容範囲を越えて進行するまでの時間を推定する暴露可能時間推定手段と、この検出された排気温度が所定値以上である時間を積算する暴露時間積算手段と、積算された暴露時間と推定された暴露可能時間とを比較して劣化回復処理時期を判定する比較判定手段とから構成される。

【0011】第4の発明は、第1または第2の発明において、前記劣化回復処理時期判定手段が、機関始動直後に劣化度合検出手段が検出した劣化度合を初期劣化度合として記憶する記憶手段と、所定時間毎に検出した劣化度合と初期劣化度合との差を算出する劣化進行度算出手段と、この劣化進行度と初期劣化度合に応じて設定される基準値とを比較して劣化回復処理時期を判定する比較判定手段とから構成される。

【0012】第5の発明は、第1～第4の発明において、前記劣化回復処理手段は、機関の空燃比を理論空燃比にフィードバック制御するときのフィードバック制御係数を補正して空燃比をリーン側にシフトさせる。

【0013】第6の発明は、第1～第4の発明において、前記劣化回復処理手段は、排気通路に設置した触媒の上流に2次空気を導入して触媒流入排気の空燃比をリーン側にシフトさせる。

【0014】

【作用】第1の発明では、触媒の一時的な劣化が判定されると、排気温度が所定値以上のときに、空燃比が理論空燃比よりもリーン側に制御され、触媒回復処理が行われる。パラジウム系触媒は、高温のリーン雰囲気に晒されることにより、触媒の一時劣化が取り除かれ、触媒性能が回復する。

【0015】したがって、触媒の劣化が判定されたときに、このように触媒の回復処理を実施することで、触媒に長期的に安定した性能をもたらすことが可能となり、良好な排気浄化機能を維持できる。

【0016】第2の発明では、触媒の劣化度合に応じて劣化回復処理に必要な時間が決められ、この設定時間だけ回復処理を行うことにより、空燃比をリーン化しての劣化回復処理に伴う運転性や排気性能に及ぼす影響を可及的に少なくし、効率的に触媒の回復処理を実施できる。

【0017】第3の発明では、機関始動直後に検出した触媒の永久劣化度合に関連して劣化回復処理時期を判定している。高温リーン雰囲気で回復する一時劣化は、常温で放置することによっても回復し、機関を停止させておくと触媒は回復する。したがって、機関の始動直後に検出された初期劣化度合は、触媒の回復不能な劣化、つまり永久劣化を表している。一時劣化の進行の速さは、永久劣化の程度に依存し、永久劣化度合が大きくなるほど進行が速まる。したがって、この永久劣化の程度に応じて、触媒の劣化が許容範囲に到達するまでの時間を推定することにより、正確に劣化回復処理時期を判定できる。

【0018】第4の発明では、初期劣化度合と所定時間毎の劣化度合との比較に応じて劣化回復処理時期を判定している。初期劣化度合と所定時間毎の劣化度合との差、つまり劣化進行度は、その運転中に進行した一時劣化の大きさを表しており、したがって、この劣化進行度を初期劣化度合に応じた基準値と比較することにより、一時劣化と永久劣化を合わせた全体の劣化が許容範囲に達するまでの時期を正確に判定することができる。

【0019】第5の発明では、空燃比フィードバック制御の制御係数（例えば比例値、積分値）を補正して空燃比をリーン化するので、このための新たなハード構成の追加が不必要となる。

【0020】第6の発明では、2次空気の導入により空燃比をリーン化するので、機関は理論空燃比など、通常の制御範囲の空燃比で運転され、劣化回復処理中でも良好な運転性を確保できる。

【0021】

【実施例】図1は本発明の実施例を示すもので、エンジン7の吸気通路8には燃料噴射弁5が取付けられ、コントローラ4からの信号に応じて燃料を噴射する。排気通路9には排気中のHC，COの酸化と、NOの還元を同時に行う三元触媒1が設置される。この三元触媒1は、アルミナに触媒金属として、パラジウム（Pd）を主に、その他セリア等を担持させたパラジウム系触媒で構成される。

【００２２】三元触媒１の上流と下流には、それぞれ第１、第２の酸素センサ２と３が設置され、コントローラ４は、第１の酸素センサ２の出力に基づいて空燃比が理論空燃比となるように、前記燃料噴量をフィードバック制御している。また、第１の酸素センサ２と、第２の酸素センサ３の出力が、それぞれリッチリーンに反転する回数を比較して、後述するように、触媒の劣化度合を検出し、この劣化に対応して、所定の運転時期に触媒の劣化回復処理を実行する。なおこのため、コントローラ４には、エンジン冷却水温を検出する水温センサ１２、三元触媒１の入口側の排気温度を検出する温度センサ１３からの信号が入力する。また、図示しないが、エンジン吸入空気量、回転数等の運転状態を代表する信号も入力する。

【００２３】なお、吸気通路８には排気通路９からの一部の排気を還流する排気還流通路１４が接続され、コントローラ４を介して排気還流制御弁１５が運転条件に応じて排気の還流量を制御し、排気中のＮＯを減少させる。

【００２４】図２にも示すように、パラジウム系触媒は、理論空燃比もしくはそれよりもリッチな高温排気雰囲気で晒すことにより、触媒性能が一時的に劣化する特性をもっている。また、これとは別に触媒の物理的な劣化に伴う永久劣化も一般的な触媒と同様に発生する。図示したものは、温度が５００℃で、空燃比が理論空燃比（λ＝１）の高温排気に長時間にわたりパラジウム系触媒を晒したときの、触媒転化率の変化の状態（一時劣化）を表している。この場合、時間の経過と共に触媒転化率は低下していくが、永久劣化の少ない触媒Ａは変化が少なく、これに対して、触媒Ｂ、Ｃと、永久劣化の進んだものほど、転化率の低下が顕著に現れる。触媒の一時劣化については、リーン空燃比の高温排気雰囲気において、回復することができ、それぞれ永久劣化の最初の状態まで、触媒性能は回復する。したがって、触媒の一時劣化の状態を判断したら、排気温度が高温となる運転条件で、一時的に空燃比をリーンに制御することで、劣化した触媒を回復させられるのである。

【００２５】このような触媒の劣化回復処理を行うために、コントローラ４は図３～図９に示す制御を行う。

【００２６】まず、図３は触媒の劣化を判断するための制御ルーチンで、機関の始動後に一回だけ実行される。

【００２７】ステップＳ１で機関冷却水温Ｔｗを読み込んだら、ステップＳ２で冷却水温Ｔｗが、例えば暖機終了後の所定値Ｔ１以上かどうか判断し、次いで、ステップＳ３で空燃比のフィードバック制御領域にあるか判断する。

【００２８】なお、いずれも異なる場合は、最初に戻る。

【００２９】ステップＳ４と５では、それぞれ触媒上流の第１の酸素センサ２と、下流の第２の酸素センサ３の出力のリッチリーンの反転周波数Ｆ１とＦ２を読み込む。反転周波数の比率、Ｆ２／Ｆ１は、図４に示すように、触媒の劣化度合が進むほど１に近づく。触媒が正常に機能しているときは、排気中の酸素をストレージするので、上流の排気中に含まれている酸素を、そのまま触媒の下流で検出することはできない。しかし、触媒が劣化してくると、上流の排気中の酸素がそのまま下流に流れる出るため、下流の酸素センサ出力の反転周波数は、上流の酸素センサ出力の反転周波数に近づいてくる。

【００３０】ステップＳ６では、この反転周波数比Ｆｒを、Ｆ２／Ｆ１として算出し、ステップＳ７で、この周波数比Ｆｒを所定値Ｆｒａと比較する。ここでは、触媒の劣化度合を判定し、検出した周波数比が所定値よりも大きいときは、触媒が劣化しているものと判断し、ステップＳ８の劣化検出ルーチンへ移行する。

【００３１】以上の制御は機関が始動される度に、始動直後（ただし触媒活性後）に一回だけ実行されるが、触媒の一時劣化は常温に放置した状態で自然に回復するため、機関を停止している間に劣化が回復し、したがって上記タイミングで検出した劣化度合（周波数比Ｆｒ：以下で初期劣化度合という）は、触媒の永久劣化のみを反映しているものとみなすことができる。

【００３２】次に図５の劣化検出ルーチンにおいて、ステップＳ１１では反転周波数比Ｆｒに基づいて、図８に示すテーブルから、数段階に設定した触媒の劣化度合Ｒｍと、触媒性能の許容範囲内でそのまま排気に晒すことが可能な暴露可能時間Ｔｃと、劣化度合に応じて決まる回復処理時間に相当する回復処理判定値Ｔｒとを読み出し、ステップＳ１２の暴露時間算出・回復処理ルーチンへ進む。

【００３３】この場合、触媒の劣化度合Ｒｍは反転周波数比Ｆｒに対応し、また、始動直後に検出した初期劣化度合Ｒｍは永久劣化度合に対応していることから、暴露可能時間Ｔｃは、この永久劣化の状態を基盤にして、排気温度がある値よりも高いときに、そのまま運転を継続したときに進行すると予測される触媒劣化度との加算値が、触媒性能の許容限度に達するまでの時間として設定されている。そして、この暴露可能時間Ｔｃに応じて回復処理判定値Ｔｒは設定される。

【００３４】なお、このルーチンはエンジンが停止するまでの間、所定の周期でもって繰り返し実行される（ステップＳ１３）。

【００３５】図６は前記した暴露時間算出・回復処理ルーチンの詳細であり、ステップＳ２１で後述する積算値Ｔｉｎ＝０にセットし、ステップＳ２２でタイマＴｉ＝０として、タイマの計数を開始すると共に、そのときの触媒入口排気温度Ｔに基づいて、図９のテーブルから重み係数Ｋｃを読み出す。この重み係数は、単位時間当たりに進行する触媒の劣化度（これは回復度にも対応）を表すもので、厳密には、排気温度と空燃比をパラメータ

とする二次元マップとなるが、排気温度の影響がより大きいので、温度のみに基くテーブル設定でもよい。

【0036】ステップＳ２３で排気温度Ｔを重み係数Ｋｃを選んだときの設定温度範囲と比較し、この温度範囲内にある時間をステップＳ２４で積算する。ただし、この積算値Ｔｉｎは、Ｔｉｎ＝Ｔｉｎ＋Ｋｃ×Ｔｉとして算出し、排気温度Ｔに基づいて求めた重み係数Ｋｃと温度範囲にあるときの時間Ｔｉとの乗算分を加算することにより、積算値を増していく。

【0037】そして、ステップＳ２５でこの積算値Ｔｉｎを暴露可能時間Ｔｃと比較し、このＴｃに達するまでは、上記ステップＳ２２からＳ２５までの積算動作を繰り返し、そのときの排気温度に応じて積算を継続し、そして積算結果が、Ｔｉｎ＞Ｔｃになったならば、図７の触媒劣化回復処理に移行する。

【0038】触媒の劣化は、高温の排気温度に晒されている時間に応じて進行し、このようにして暴露可能時間Ｔｃとの関係で、劣化の進行を判断するのである。

【0039】図7において、ステップＳ２６では、まず積算値Ｔｉｎ＝0にリセットし、ステップＳ２７で触媒入口温度Ｔが、劣化回復処理が可能な所定値以上の高温状態かどうかを判断し、さらにステップＳ２８では、運転条件が高負荷のリッチ空燃比領域（KMR）かどうか判断する。

【0040】このリッチ空燃比領域では、触媒劣化回復処理のためリーンシフトしようとしても、運転性の点からKMRが優先され、リーンシフトできないので、それまでの回復処理の経過を無視して、最初からやり直す。

【0041】KMRにないときは、ステップＳ２９で、タイマＴｉ＝０として、タイマの計数を開始し、触媒入口温度Ｔに基づいて図９のテーブルから、重み係数Ｋｒを読み出し、ステップＳ３０で空燃比フィードバック制御の制御係数（例えば比例値、積分値）を変更し、フィードバック制御の制御中心をリーン側にシフトし、劣化回復処理に移行する。なお、このとき、同時に排気還流量を増量し、空燃比リーン化により、三元触媒で浄化処理できなくなったNOを低減する。

【0042】前述のように、触媒に流入する排気温度が高温の状態において、空燃比をリーン化することで、劣化したパラジウム系触媒は、永久劣化を除き、一時劣化分の回復が図られるのである。

【0043】ステップＳ３１、Ｓ３２で一定温度以上の状態での時間を積算する。この積算値Ｔｉｍは、Ｔｉｍ＝Ｔｉｍ＋Ｋｒ×Ｔｉとして算出される。ステップＳ３１で排気温度が所定の温度範囲から変化したら、ステップＳ３２でタイマを停止し、ステップＳ３３を経由して、再びステップＳ２７に戻り、劣化処理時間の積算を継続する。

【0044】なお、この場合も、劣化の回復が、リーン雰囲気の排気の温度に大きく影響されるため、排気温度にのみ依存して設定した図９のテーブルから、重み係数Ｋｒを設定することができるのである。

【0045】ステップＳ３３では、積算値Ｔｉｍを、前記した回復処理判定値Ｔｒと比較することにより、回復処理が完了したかどうかを判断する。このようにして、検出された触媒の劣化度合に対応した回復処理時間を経過したならば、触媒の一時劣化は、初期状態まで回復（ただし永久劣化分は除く）したものと判断し、ステップＳ３４に進み、空燃比のフィードバック制御の制御係数と、排気還流率（ＥＧＲ率）を通常の運転状態の値に戻し、劣化回復処理を終了する。

【0046】空燃比をリーン化するのに、フィードバック制御係数を補正する代わりに、三元触媒１の上流かつ酸素センサ２の下流に２次空気を導入する装置を設け、ステップＳ３０において、触媒の上流に２次空気を導入し、触媒流入排気をリーン化してもよい。この場合、エンジン空燃比は、通常の理論空燃比となるので、触媒の劣化回復処理を行っても、良好な運転性を確保できる。

【0047】次に、図１０、図１１に示す他の実施例を説明する。

【0048】この実施例は、前記触媒の劣化の進行度が、永久劣化度合、つまり機関始動直後に検出した初期劣化度合に関連していることから、この劣化度合に応じた基準値に基づいて、一時劣化と永久劣化を合わせた全体の劣化が許容限度に達するまでの時期を判定するようにしたのである。

【0049】まず、図１０のルーチンは、機関を始動するたびに一回だけ実行されるもので、ステップＳ４１からステップＳ４６までは、図３の基本ルーチンの、ステップＳ１～ステップＳ６と同一であり、ステップＳ４７において、反転周波数比Ｆｒにより図８のテーブルから求めた劣化度Ｒｍを、初期劣化度Ｒｍｏとして記憶すると共に、このＲｍｏに基づいて、図１２のテーブルから、基準値Ｒｍｃを読み出す。この基準値Ｒｍｃは、Ｒｍｏ＋Ｒｍｃが触媒性能の劣化限度となるように決められ、初期劣化度Ｒｍｏが大きくなるほど、Ｒｍｃは小さくなる。

【0050】つまり、ここでは、機関始動後に一回行われる、触媒の劣化判定から、この劣化度合を初期劣化として記憶しておく。

【0051】そして、図１０のルーチンに移行する。このルーチンは機関運転後の所定時間毎に繰り返し実行されるもので、触媒の劣化の進行度を判定するもので、ここのステップＳ５１～ステップＳ５４までは、同じく上記ステップＳ２～ステップＳ６までと同一の内容であり、ここでは排気温度が所定値以上のときの、酸素センサ出力の反転周波数比Ｆｒを算出したら、ステップＳ５５で、このＦｒに基づいて、図８のテーブルから劣化度合Ｒｍを読み出し、これと前記初期劣化度合Ｒｍｏとの差、つまり一時劣化の進行度ΔＲｍを、ΔＲｍ＝Ｒｍ－

Ｒｍｏとして算出する。機関の始動直後に検出した初期劣化度合は、永久劣化度合に対応するから、このΔＲｍは、回復可能な触媒の一時劣化を表す。

【００５２】ステップＳ５６でこの一時劣化進行度ΔＲｍを基準値Ｒｍｃと比較する。初期劣化度合、つまり永久劣化度合が進んでいるほど、基準値Ｒｍｃは小さい値となり、この場合には、それだけ一時劣化の許容度も小さくなる。もし、一時劣化度合ΔＲｍが、基準値Ｒｍｃ以下でないときは、触媒の回復処理ルーチンに移行するためステップＳ５７に進み、回復処理判定値Ｔｒを読み出し、ステップＳ５８の回復処理動作を実行する。

【００５３】なお、この回復処理ルーチンは、前記した図７のステップＳ２６からステップＳ３４と同一の動作内容となっていて、高温排気雰囲気での空燃比のリーン化により、回復処理判定値Ｔｒに達するまでの期間、触媒の劣化回復処理を行うのである。

【００５４】このようにして、機関始動直後に検出した初期劣化度合に応じた基準値に基づいて、一時劣化と永久劣化を合わせた全体の劣化が許容限度に達するまでの時期を判定するので、触媒を回復処理するための制御を、劣化の状態を正確に判断しながら効率よく行うことができる。

【００５５】

【発明の効果】以上のように第１の発明は、触媒金属として主にパラジウムを担持させた機関排気系に設置される排気浄化用の触媒と、この触媒の劣化度合を検出する劣化度合検出手段と、触媒に流入する排気温度を検出する排気温度検出手段と、検出された触媒劣化度合に応じて触媒の劣化回復処理を行う時期を判定する劣化回復処理時期判定手段と、この判定結果が劣化回復処理時期にありかつ検出された排気温度が所定値以上であるときに排気の空燃比を理論空燃比よりもリーン側の劣化回復処理空燃比に制御して触媒の劣化回復処理を行う劣化回復処理手段とを備えたため、触媒の一時的な劣化が判定されると、排気温度が所定値以上のときに、排気空燃比をリーン制御し、触媒の回復処理を行うので、常に良好な触媒性能を維持し、排気エミッションを改善することができる。

【００５６】第２の発明は、触媒金属として主にパラジウムを担持させた機関排気系に設置される排気浄化用の触媒と、この触媒の劣化度合を検出する劣化度合検出手段と、触媒に流入する排気温度を検出する排気温度検出手段と、検出された触媒劣化度合に応じて触媒の劣化回復処理を行う時期を判定する劣化回復処理時期判定手段と、検出された触媒劣化度合に応じて触媒の劣化回復処理を行う時間を設定する劣化回復処理時間設定手段と、前記判定結果が劣化回復処理時期にありかつ検出された排気温度が所定値以上であるときに排気の空燃比を理論空燃比よりもリーン側の劣化回復処理空燃比に制御して触媒の劣化回復処理を行う劣化回復処理手段と、この劣化回復処理に移行してからの積算時間が設定された劣化回復処理時間に達したときに劣化回復処理を終了させる劣化回復処理終了手段とを備えたため、触媒の劣化度合に応じて劣化回復処理に必要な時間が決められ、この設定時間だけ回復処理を行うので、空燃比をリーン化しての劣化回復処理に伴う運転性や排気性能に及ぼす影響を可及的に少なくし、効率よく触媒の回復処理を実施できる。

【００５７】第３の発明は、第１または第２の発明において、前記劣化回復処理時期判定手段が、機関始動直後の触媒劣化度合の検出値に基づいて、触媒を所定温度以上の排気に晒したときに劣化度合が許容範囲を越えて進行するまでの時間を推定する暴露可能時間推定手段と、検出された排気温度が所定値以上である時間を積算する暴露時間積算手段と、積算された暴露時間と推定された暴露可能時間とを比較して劣化回復処理時期を判定する比較判定手段とから構成されるので、触媒の永久劣化の程度に応じて、一時劣化が許容範囲に到達するまでの時間を推定することにより、正確に劣化回復処理時期を判定できる。

【００５８】第４の発明は、第１または第２の発明において、前記劣化回復処理時期判定手段が、機関始動直後に劣化度合検出手段が検出した劣化度合を初期劣化度合として記憶する記憶手段と、所定時間毎に検出した劣化度合と初期劣化度合との差を算出する劣化進行度算出手段と、この劣化進行度と初期劣化度合に応じて設定される基準値とを比較して劣化回復処理時期を判定する比較判定手段とから構成されるので、触媒の劣化進行度を初期劣化度合と比較することにより、一時劣化と永久劣化を合わせた全体の劣化が許容範囲に達するまでの時期を正確に判定することができる。

【００５９】第５の発明は、第１～第４の発明において、前記劣化回復処理手段は、機関の空燃比を理論空燃比にフィードバック制御するときのフィードバック制御係数を補正して空燃比をリーン側にシフトさせるので、劣化処理のために空燃比をリーン化するのに、新たなハード構成の追加が不必要で、構成が簡略化される。

【００６０】第６の発明は、第１～第４の発明において、前記劣化回復処理手段は、排気通路に設置した触媒の上流に２次空気を導入して触媒流入排気の空燃比をリーン側にシフトさせるので、劣化回復処理のために空燃比をリーン化しても、機関の空燃比は通常の制御範囲にあるため、劣化回復処理中でも良好な運転性を確保できる。

【図面の簡単な説明】

【図１】本発明の実施例を示す概略構成図である。

【図２】触媒性能の変遷状態を示す説明図である。

【図３】上記実施例の触媒の劣化検出の制御動作を示すフローチャートである。

【図４】同じく触媒の劣化判定の説明図である。

【図５】同じく触媒の劣化判定の制御動作を示すフローチャートである。

【図６】同じく触媒の暴露時間設定の制御動作を示すフローチャートである。

【図７】同じく劣化回復処理の制御動作を示すフローチャートである。

【図８】反転周波数比と劣化度合等の関係を示す説明図である。

【図９】触媒入口温度と重み係数の関係を示す説明図である。

【図１０】他の実施例の制御動作を示すフローチャートである。

【図１１】同じく触媒の劣化進行判定の制御動作のフローチャートである。

【図１２】初期劣化度と基準値の関係を示す説明図である。

【図１３】劣化進行度と回復処理判定値の関係を示す説明明図である。

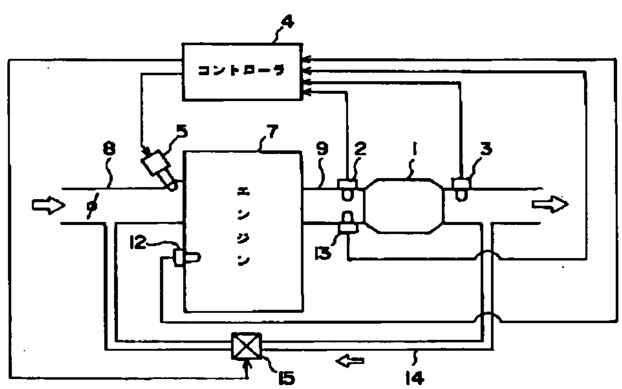
【図１４】第１の発明の構成図である。

【図１５】第２の発明の構成図である。

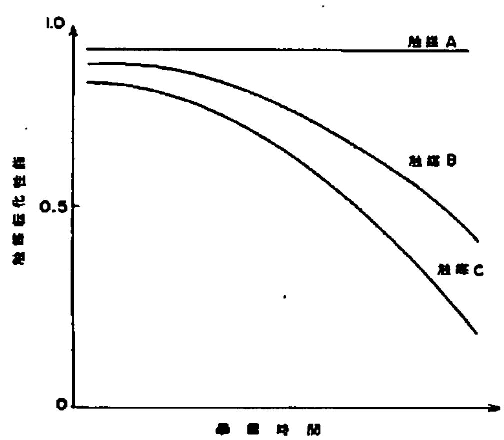
【符号の説明】

1　三元触媒（パラジウム系触媒）
2　酸素センサ
3　酸素センサ
4　コントローラ
5　燃料噴射弁
9　排気通路
１３　排気温度センサ
５１　劣化度合検出手段
５２　劣化回復処理時期判定手段
５３　劣化回復処理手段
５４　劣化回復処理時間設定手段
５５　劣化回復処理終了手段

【図１】

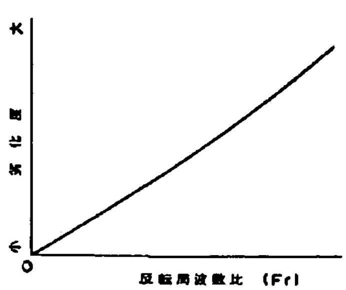


【図２】

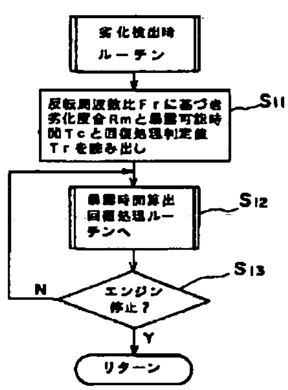


（500°C　λ=1）

【図４】



【図５】



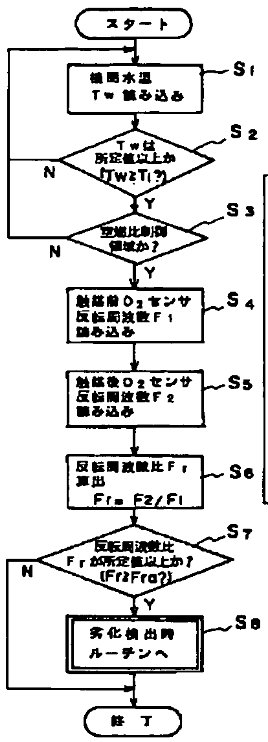
【図８】

反転周波数比	Fr	Fr_1	Fr_2		Fr_ℓ
劣化度合	Rm	Rm_1	Rm_2		Rm_ℓ
暴露可能時間	Tc	Tc_1	Tc_2		Tc_ℓ
回復処理判定値	Tr	Tr_1	Tr_2		Tr_ℓ

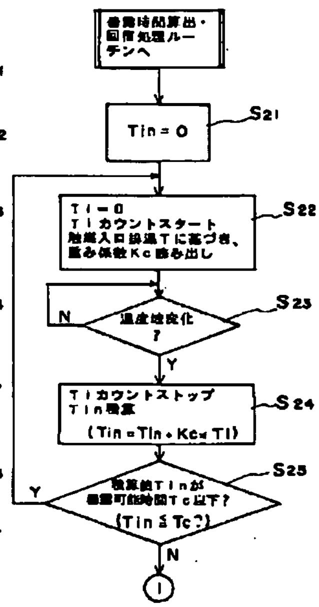
【図９】

触媒入口排温	T	T_1	T_2		T_m
重み係数	Kc	Kc_1	Kc_2		Kc_m
重み係数	Kr	Kr_1	Kr_2		Kr_m

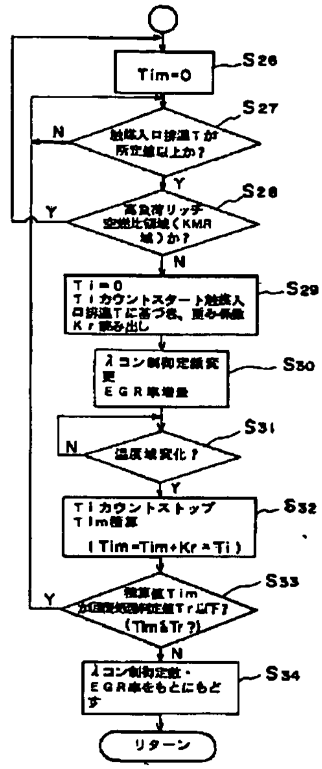
【図3】



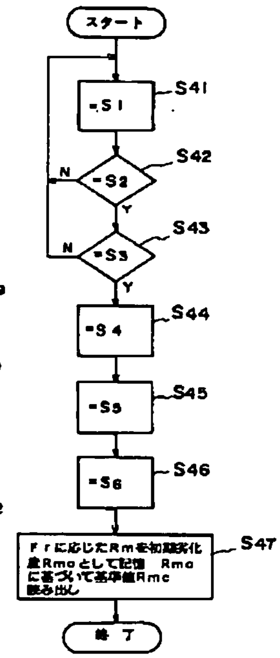
【図6】



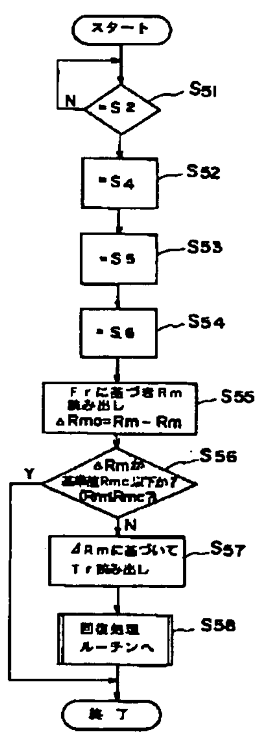
【図7】



【図10】



【図11】



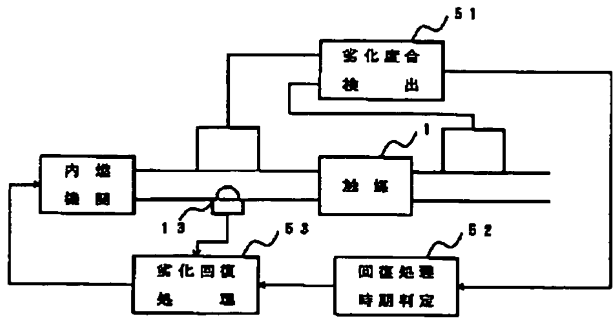
【図12】

初期劣化度	Rmo	Rmo1	Rmo2	……	Rmoℓ
基準値	Rmc	Rmc1	Rmc2	……	Rmcℓ

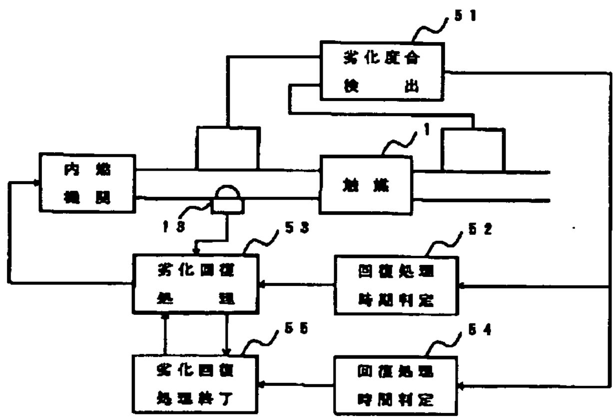
【図13】

劣化進行度	ΔRm	ΔRm1	ΔRm2	……	ΔRmℓ
回復処理判定値	Tr	Tr1	Tr2	……	Trℓ

【図14】



【図15】



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